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## CLAIMS

WHAT IS CLAIMED IS:

1. A method of forming a metal container of defined shape and lateral dimensions, comprising

(a) disposing a hollow metal preform having a closed end in a die cavity laterally enclosed by a die wall defining said shape and lateral dimensions, with a punch located at one end of the cavity and translatable into the cavity, the preform closed end being positioned in proximate facing relation to the punch and at least a portion of the preform being initially spaced inwardly from the die wall;

(b) subjecting the preform to internal fluid pressure to expand the preform outwardly into substantially full contact with the die wall, thereby to impart said defined shape and lateral dimensions to the preform, said fluid pressure exerting force, on said closed end, directed toward said one end of the cavity; and

(c) translating the punch into the cavity to engage and displace the closed end of the preform in a direction opposite to the direction of force exerted by fluid pressure thereon, deforming the closed end of the preform.

2. A method according to claim 1, wherein the punch is moved into the cavity after the preform begins to expand but before expansion of the preform is complete in step (b).

3. A method according to claim 1, wherein the punch is moved into contact with the closed end of the preform before commencing expansion of the preform and the contact is maintained throughout the expansion of the preform.

4. A method according to claim 1, wherein said punch has a contoured surface, the closed end of the preform being deformed so as to conform to said contoured surface.

5. A method according to claim 1, wherein said defined shape is a bottle shape including a neck portion and a body portion larger in lateral dimensions than the neck portion, said die cavity having a long axis, said preform having a long axis and being disposed substantially coaxially with said cavity in step (a), and said punch being translatable along the long axis of the cavity.

6. A method according to claim 5, wherein said punch has a domed contour, and wherein step (c) deforms said closed end of said preform into said domed contour.

7. A method according to claim 5, wherein said die wall comprises a split die separable for removal of the formed container following step (c).

8. A method according to claim 7, wherein said defined shape is asymmetric about said long axis of said cavity.

9. A method according to claim 5, wherein said punch is initially positioned, at the start of step (b), to limit axial lengthening of the preform by said fluid pressure.

10. A method according to claim 5, wherein step (c) is initiated at substantially the same time that said portion of the preform begins to come into contact with the die wall.

11. A method according to claim 5, wherein said preform is an elongated and initially generally cylindrical workpiece having an open end opposite said closed end and is substantially equal in diameter to said neck portion of said bottle shape.

12. A method according to claim 11, wherein said workpiece has sufficient formability to be expandable to said defined shape in a single pressure forming operation.

13. A method according to claim 11, including a preliminary steps of placing the workpiece in a die cavity smaller than the first-mentioned die cavity and subjecting the workpiece therein to internal fluid pressure to expand the workpiece to an intermediate size and shape smaller than said defined shape and lateral dimensions, before performing steps (a), (b) and (c).

14. A method according to claim 5, wherein said preform is an elongated and initially generally cylindrical workpiece having an open end opposite said closed end and is larger in diameter than said neck portion of said bottle shape; and including a further step of subjecting the workpiece, adjacent said open end, to a spin forming operation to form a neck portion of reduced diameter, after performance of steps (a), (b) and (c).

15. A method according to claim 1, wherein said preform is an aluminum preform.

16. A method according to claim 15, including the step of making the preform from aluminum sheet having a recrystallized or recovered microstructure with a gauge in a range of about 0.25 to about 1.5 mm, prior to performance of step (a).

17. A method according to claim 16, wherein said preform is produced as a closed end cylinder by subjecting said sheet to a draw-redraw operation or back extrusion.

18. A method according to claim 1, wherein, during step (b), fluid pressure within the preform occurs in successive stages of (i) rising to a first peak before expansion of the preform begins, (ii) dropping to a minimum value as expansion commences, (iii) rising gradually to an intermediate value as expansion proceeds until the preform is in extended though not complete contact with the die wall, and (iv) rising from the intermediate value during completion of preform expansion; and wherein initiation of translation of the punch in step (c) to

displace and deform the closed end of the preform occurs substantially at the end of stage (iii).

19. A method according to claim 1, wherein, during step (b), the closed end of the preform assumes an enlarged and generally hemispherical configuration as said portion of the preform comes into initial contact with the die wall in step (b); and wherein initiation of translation of the punch in step (c) to displace and deform the closed end of the preform occurs substantially at the time that the preform closed end assumes said configuration.

20. A method according to claim 1, wherein step (b) comprises simultaneously applying internal positive fluid pressure and external positive fluid pressure to the preform in the cavity, said internal positive fluid pressure being higher than said external positive fluid pressure.

21. A method according to claim 20, including controlling strain rate in the preform by independently controlling the internal and external positive fluid pressures to which the preform is simultaneously subjected for varying the differential between said internal positive fluid pressure and said external positive fluid pressure.

22. A method according to claim 3, wherein heat is applied to the preform by way of heating means in the punch to thereby induce a temperature gradient to the preform commencing at the closed bottom and extending upwardly.

23. A method according to claim 3, wherein heat is applied to the preform by way of heating means around the top of the preform in the die to thereby induce a temperature gradient to the preform commencing at the top and extending downwardly.

24. A method according to claim 22, wherein heat is applied to the preform by way of heating means in the side walls of the die.

25. A method according to claim 23, wherein heat is applied to the preform by way of heating means in the side walls of the die.

26. A method according to claim 1, wherein the punch is actuated to displace and deform the closed end of the preform substantially at the end of the expansion phase.

27. A method according to claim 1, wherein the die cavity has a second end opposed to said one end and an axis extending therebetween, and wherein the die wall comprises a split die comprising a plurality of split inserts disposed in tandem along said axis for defining successive portions of said shape and separable for removal of the formed container following step (c).

28. A method according to claim 27, wherein said split inserts are removably and replaceably received within a split holder that maintains the inserts in fixed die-cavity-defining position during performance of steps (b) and (c).

29. A method according to claim 28, wherein at least one of said inserts has an inner surface bearing a relief feature for imparting a corresponding relief feature to the container.

30. A method according to claim 29, further comprising the steps of selecting said at least one insert from a group of interchangeable inserts having inner surfaces respectively bearing different relief features, and disposing the selected insert in said holder, before performing step (b).

31. A method according to claim 20, wherein said internal and external positive fluid pressures are applied by feeding gas

to the interior of the preform and to the die cavity externally of the preform, respectively, through separate channels.

32. A method according to claim 1, wherein the die wall comprises die structure having upper and lower portions and wherein heat is applied to the preform by two groups of heating elements respectively incorporated in the upper and lower portions of the die structure and under independent temperature control for controlling temperature gradient in the preform.

33. A method according to claim 1, wherein heat is applied to the preform by a heating element disposed within the preform substantially coaxially therewith.

34. A method according to claim 33 wherein heat is further supplied to the preform by heating the punch.

35. A method according to claim 5 wherein the neck portion of the defined shape includes a screw thread or lug for securing a screw closure to the formed container and wherein the die wall has a neck portion with a thread or lug formed therein for imparting a thread to the preform during performance of step (b).

36. Apparatus for forming a metal container of defined shape and lateral dimensions from a hollow metal preform having a closed end, comprising

(a) die structure providing a die cavity for receiving the preform therein with at least a portion of the preform being initially spaced inwardly from the die wall and the preform closed end facing one end of the cavity, said cavity having a die wall defining said shape and lateral dimensions;

(b) a punch located at one end of the cavity and translatable into the cavity such that the closed end of a preform received within the cavity is positioned in proximate facing relation to the punch;

(c) a fluid pressure supply for subjecting a preform within the cavity to internal fluid pressure to expand the preform

outwardly into substantially full contact with the die wall, thereby to impart said defined shape and lateral dimensions to the preform, said fluid pressure exerting force, on said closed end, directed toward said one end of the cavity;

(d) the die cavity having a second end opposed to said one end and an axis extending therebetween;

(e) the die wall comprising a split die including a plurality of split inserts disposed in tandem along said axis for defining successive portions of said shape and separable for removal of the formed container from the cavity.

37. Apparatus as defined in claim 36, wherein the die structure comprises a split holder within which the split inserts are removably and replaceably received, for maintaining the inserts in fixed die-cavity-defining position during expansion of a preform within the cavity.

38. Apparatus as defined in claim 37, wherein at least one of said inserts has an inner surface bearing a relief feature for imparting a corresponding relief feature to the container.

39. Apparatus as defined in claim 38, further comprising a group of interchangeable inserts having inner surfaces respectively bearing different relief features, from which one or more split inserts are selected for insertion in said holder.

40. Apparatus as defined in claim 36, further including separate gas-feeding channels for respectively feeding gas to the interior of the preform and to the die cavity externally of the preform, to apply internal and external positive fluid pressures to a preform within the die cavity.

41. Apparatus as defined in claim 36, wherein the die structure has upper and lower portions and two groups of heating elements respectively incorporated in the upper and lower portions of the die structure and under independent temperature control for controlling temperature gradient in the preform.

42. Apparatus as defined in claim 36, further including a heating element insertable within a preform in the die cavity substantially coaxially therewith.

43. Apparatus as defined in claim 36, further including a heating element for heating the punch.

44. Apparatus as defined in claim 36, wherein the neck portion of the defined shape includes a screw thread or lug for securing a screw closure to the formed container and wherein the die wall has a neck portion with a thread or lug formed therein for imparting a thread or lug to a preform disposed in the die cavity.

45. A method according to claim 5 wherein the neck portion of the defined shape includes a neck ring and wherein the die wall has a neck portion with a relief feature formed therein for imparting a neck ring to the preform during performance of step (b).